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UNITED STATES DEPARTMENT OF AGRICULTURE

Functional Requirements in Designing Laying Houses For Poultry

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TO AID in the design and construction of more satisfactory farm buildings the Agricultural Research Administration, of the United States Department of Agriculture, with the cooperation of the State agricultural experiment stations, is preparing statements on the functional requirements of buildings for farm animals. This circular is the third of the series.[2] It is based largely on a consensus of poultry and building specialists of the State agricultural colleges

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[1] The preliminary draft of this circular was prepared by the late M. A. R. Kelley, Bureau of Plant Industry, Soils, and Agricultural Engineering; A. R. Lee, Bureau of Animal Industry; and S. S. Landess and J. L. Strahan, Farm Security Administration.

[2] The first two were Circular 701, Hog-Housing Requirements; and Circular 722, Functional Requirements in Designing Dairy Barns.

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and the United States Department of Agriculture. Before facts instead of opinions can be presented, much further study of poultry housing is needed.

So far as possible, the requirements stated are in terms of space to be provided or function to be performed. They do not specify the use of any particular material, as many war developments in the use of materials are likely to be applied in farm construction.

State agencies using this information in educational and construction programs may wish to supplement it with more detailed statements applicable to their areas.

DISTRIBUTION OF CHICKENS BY SIZE OF FLOCK AND BY REGIONS

Of more than 6 million farms throughout the United States that in the 1940 census reported on chicken raising, 15 percent specified none (table 1); 50 percent reported flocks of less than 50 hens; 30 percent, flocks of 50 to 199; 5 percent, flocks of 200 to 699; and less than 0.5 percent had flocks of more than 700 hens. Only 21 percent of the chickens, however, were on the farms having less than 50 hens each; 48 percent were in flocks of 50 to 199; 22 percent in flocks of 200 to 699; and 9 percent in flocks of 700 or more hens per farm.

The large percentages of farms having small flocks and the total number of chickens in such flocks justify the development of better types of small low-cost houses. The advantage of having good housing conditions and labor-saving conveniences increases with the size of the flock. To avoid large losses of fowls, low production, and high feed and labor costs in large enterprises, the best of care and of housing conditions must be provided. Special equipment may be needed to save the labor involved in handling the large quantities of feed, litter, manure, and eggs.

TABLE 1.—*Farms reporting chickens,*[1] *by size of flock and geographic divisions, Apr. 1, 1940*

Geographic division	Farms	Percentage of farms reporting specified numbers of chickens							
		None	1–24	25–49	50–99	100–199	200–399	400–699	700 or more
	Number	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
New England	135,190	46	22	13	7	4	4	2	2
Middle Atlantic	348,100	24	17	19	17	12	7	3	1
East North Central	1,006,095	16	13	19	26	20	5	1	(3)
West North Central	1,090,574	12	9	15	25	28	10	1	(3)
South Atlantic	1,019,451	13	42	28	11	4	1	(2)	(3)
East South Central	1,023,349	12	44	29	12	3	(2)	(3)	(3)
West South Central	964,370	11	31	29	19	9	1	(2)	(3)
Mountain	233,497	27	23	21	17	8	3	1	(3)
Pacific	276,173	35	27	16	9	5	3	2	3
Total for the United States	6,096,709	15	27	23	18	12	4	1	(2)

[1] Includes all over 4 months old.
[2] Less than ½ of 1 percent.
[3] Less than 1/10 of 1 percent.

CLIMATIC CONDITIONS AFFECTING LAYING-HOUSE REQUIREMENTS

Hens in all sections must be protected from rain and excessive summer heat. In winter they need protection from low temperatures, extreme changes in temperature, cold winds, dampness, rain, and snow. The most severe conditions are found in the northern parts of North Dakota, Minnesota, and Wisconsin, where the average temperature is below 10° F. in January (fig. 1), the average relative humidity above 80 percent (fig. 2), and the average winter sunshine less than 5 hours per day (fig. 3). Average January relative humidity above 80 percent and less than 3 hours per day of winter sunshine, but somewhat milder temperatures, occur in parts of the Pacific Northwest and the central Great Lakes region. The highest winter temperatures occur along the Gulf of Mexico and in Florida, and the lowest relative humidity and the most sunshine are in Arizona and adjoining States. Similar data for other parts of the country are mapped in figures 1 to 3.

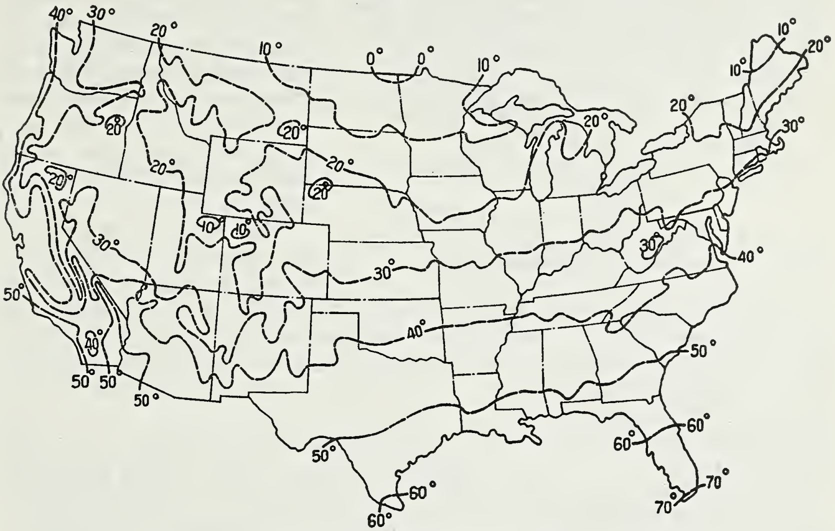

FIGURE 1.—Average January temperature, °F.

For farm-building purposes the country may be divided into four zones, based on the average January temperature and relative humidity, as mapped in figure 4. The boundary between zones 2 and 3 is the 35° isotherm and that between zones 3 and 4 the 50° isotherm. The boundary between zones 1 and 2 is adjusted to take account of the effect of high relative humidity in increasing heat loss by ventilation. Where the average relative humidity in January is 70 percent, the zone boundary coincides with the 20° isotherm. Where it is above 80 percent, the boundary approaches the 25° isotherm. Minimum temperatures—about 40° lower than the January average—occur once or twice a year in most of zones 1 and 2. In zones 3 and 4 the minimum is usually about 30° lower than the January average except along the west coast. There are no abrupt changes at the zone lines, and except as influenced by altitude the changes are noticeable only over considerable distances. The climate within all zones changes with altitude, the average temperature being about 1° lower for each 400-foot rise above the average elevation of the area.

THE HEN AND HER HABITS

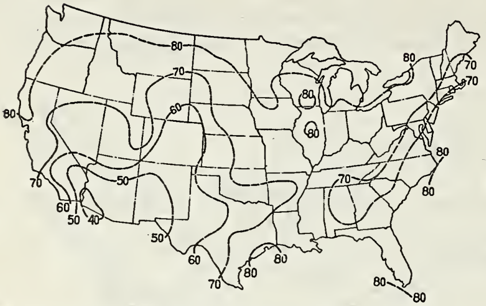

FIGURE 2.—Percentage of average relative humidity in January.

The hen is the most widely domesticated member of the poultry family. Improved feeding, breeding, and management have developed some flocks in which individual hens produce more than 200 eggs a year and exceptional individuals 300 or more eggs in their pullet year.

The body temperature of the hen is 106° F., which is higher than that of other domestic livestock; her breathing is rapid and her pulse and metabolic rate high. She has no sweat glands, her temperature being regulated by evaporation of moisture from the respiratory organs. In hot weather she gets some relief by fluffing the feathers and holding the wings away from the body.

Hens are kept successfully under widely different climatic conditions, but are affected adversely by extremes or sudden severe changes of temperature and by cold drafts. They lay best in spring when it is about 50° to 60° F. outdoors. Egg production is materially reduced by low or high temperatures or by extreme sudden changes. The comb and wattles are likely to freeze at about 10° in cold regions or below 20° in milder areas, the temperature varying with heredity and physical condition, the temperatures to which the hens are accustomed, the suddenness of the change, and the quantity of moisture in the air.

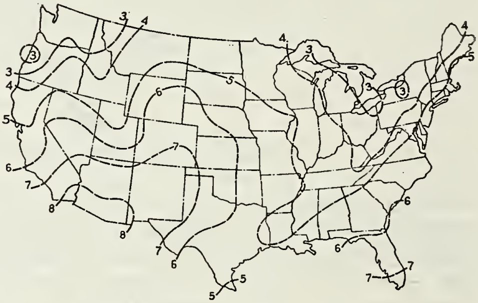

FIGURE 3.—Average number of hours of winter sunshine daily, December, January, and February.

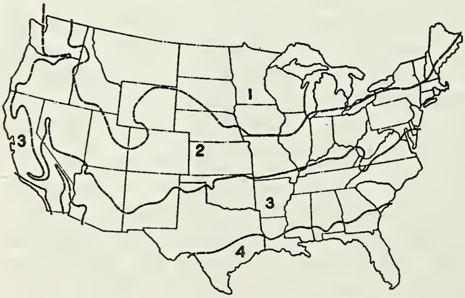

FIGURE 4.—Farm-building zone map.

Egg production is closely related to length of daylight. Lengthening the day by artificial lighting of poultry houses has proved an effective means of increasing production in winter by stimulating the hen's glandular activity and increasing her feed consumption.

Though omnivorous feeders, hens eat chiefly a concentrated diet consisting largely of grains. Cleanliness is difficult to maintain, because liquids are voided with droppings and the hens jump and perch on equipment in all parts of the house, carrying filth on their feet, especially if floors are wet. Hens are subject to numerous diseases, insect infestations, and bad habits that are likely to increase in proportion to the number of birds in the flock, with crowding, with lack of sanitation around the premises, and with improper care and feed. Having a nervous temperament and being easily frightened, hens prefer secluded places to lay and will seek the highest roost at night. They will pick and eat particles from walls or other building materials, especially if these have a fibrous or granular appearance.

ENVIRONMENTAL STANDARDS FOR LAYING HENS[3]

Location of the Poultry House

For the farm flock a site for the laying house near other buildings facilitates feeding and if within view of the farmhouse permits better protection from marauders. The site should be large enough to provide for necessary yards and future expansion. Locating large laying houses at least 100 feet from other structures reduces fire risk. Consideration should be given to service roads, water supply, electric lines, and land contour.

The site should be on relatively high ground, preferably on a south or southeast slope where natural drainage is away from the building, never at the foot of a slope where either soil or air drainage is poor. Rolling land may permit entering upper-floor feed rooms by ramps or at truck-level platforms. In irrigated areas ditch seepage must be avoided.

A windbreak is desirable for protection from cold winds, and shade is beneficial in summer, but the house should not be built within a dense enclosure of trees or in the lee of tall buildings that would stop summer breezes or shade the house from winter sunshine.

Poultry houses are ordinarily faced south, southeast, or east. Although the southern exposure is most common, facing east or southeast permits the sun to enter the house earlier in the morning and is more effective in excluding hot afternoon sun.

Space Requirements

The space allowances recommended for ordinary conditions range from 2¾ to 4½ square feet for each hen, depending on breed and size of flock (table 2). If hens are confined in hot weather, the number per pen should be reduced to allow half a square foot more of floor

Table 2.—*Floor space required for poultry of small and of large breeds*

Breed size	Hens in pen	Floor space per hen
	Number	*Square feet*
Small	25	4
	100	3½
	200	3
	400	2¾
Large	25	4½
	100	4
	200	3½
	400	3¼

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[3] The Rutgers Farm Building Institute gave valuable assistance in obtaining information on this subject.

space per hen. Where they have free outdoor range throughout the year, the floor space may be reduced to 2 to 2½ square feet.

A house for a small flock may be 10 by 12 feet to 14 by 14 feet, allowing floor space as indicated in table 2. In small houses the depth should be the greater dimension. Larger units are commonly 20 feet square for about 100 hens and 24 feet square for about 150. In zones 1 and 2, single-pen houses 30 to 36 feet square are used for flocks numbering 300 to 400. Flocks of 150 or more may be accommodated in long houses of widths up to about 36 feet and with partitions preferably not more than 40 feet apart. If more than about 1,200 hens are to be housed, a two-, three-, or four-story house may be considered (*7*).[4] Multistory houses should be at least 24 feet deep.

A height of 6 feet 2 inches to the lower side of rafters or ceiling at the front of the roosting space is the minimum for convenience. A ceiling at least 7 feet high is needed if deep litter or a litter carrier is to be used. Roof or ceiling height in the South is usually 1 to 2 feet higher than in the North.

YARDS

If yards are to be provided, 175 to 200 square feet per hen should be ample. They should be of such size and so located as to permit cultivation and keeping them free from contamination. Medium sandy soils are desirable; heavy clay soils are not suitable for a poultry yard. If less space is available, it is well to divide the yards into two or three lots to be used alternately to improve sanitation and provide green feed. For commercial and for back-yard flocks yards are often not used.

In some areas paved outside runs one-half to two-thirds the width of the house are used. In other cases outdoor sun porches are provided. These may be smaller than the paved runs and should have wire floors to keep the hens off the ground.

TEMPERATURE

Temperature requirements (*6, 17*) in the laying house are affected by climate and by feeding and management practices. In summer the temperature should not be higher than that of the outside air. Some poultrymen are of the opinion that breeding stock should be exposed to rigorous housing conditions as a means of eliminating weak hens. Available information indicates that in houses for commercial egg production with ordinary feeding, winter temperatures above the following minimums are desirable:

	Ordinary °*F.*	*Extreme* °*F.*
Zone 1	32	15
Zone 2	40	20
Zone 3	45	25
Zone 4	50	32

RELATIVE HUMIDITY

To minimize moisture condensation on walls and ceilings and to avoid odors that might affect egg quality, there should be enough air change through the house to keep the relative humidity below 80 percent in ordinary winter weather.

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[4] Italic numbers in parentheses refer to Literature Cited, p. 15.

LITTER MOISTURE

The moisture content of the litter (*2*) should not exceed 40 percent (wet basis), as wet litter increases the number of dirty eggs and adds to the labor of caring for the flock. It also may aid spread of disease among the hens.

LIGHT

Daylight, well distributed throughout the house, is needed for the hens to feed and for attendants to work in. Window-opening space for light may range from about 5 percent of the floor area in zone 1 to about 25 percent in zone 4. The lower proportions are recommended for the colder areas because of the large heat loss through glass or cloth when the sun is not shining. Moreover, as ultraviolet rays do not pass through ordinary window glass, a large window area is not a substitute for direct sunlight or vitamin D in the feed. Some glass substitutes pass ultraviolet rays when new, thus supplying some vitamin D. Unless carefully installed and handled, however, most substitutes are short-lived, and unless kept clean and taken out in summer they lose effectiveness.

Artificial lighting is being used increasingly to lengthen the hens' day to 12 to 14 hours, thus stimulating activity of the reproductive organs and increasing the hours of feeding. Two 40- to 60-watt lights with reflectors are needed over the feed hoppers in a 20-foot length of pen. Dimming the lights just before they are turned off or leaving a 10-watt light burning in each pen will help to get the hens on the roosts. Where lights are used all night, 15-watt lamps may be used instead of the larger sizes.

TYPES OF LAYING HOUSES[5]

In zones 1 and 2, laying houses are usually built on permanent foundations, though movable colony houses are used to some extent. In zone 4 and parts of zone 3, where the climate permits year-round grazing, movable colony houses are often used for commercial as well as for farm flocks. For convenience in handling, the maximum size for a movable house is about 12 by 14 feet.

There are three general types of poultry laying houses:

1. The uninsulated building having large front wall openings, often provided with windows or curtains that can be closed during storms or cold nights. This type is generally recommended by the State agricultural experiment stations for use in zones 3 and 4 and to some extent in zone 2. In the past such houses were generally recommended for all parts of the United States (*1, 4, 8, 11, 12*).
2. The straw-loft house with ventilated attic. This type, with insulated walls and some control of ventilation, is recommended by most of the agricultural experiment stations in zone 1; with uninsulated walls, it is widely used in zone 2 and to some extent in zone 3 (*9, 16, 18*).
3. The tightly built insulated house with controlled ventilation. This type, in sizes 20 feet square and larger, is recommended by agricultural experiment stations in most of the Northeastern and some of the other Northern States (*3, 7, 15*).

In cold weather, insulation and controlled ventilation have four advantages.

1. Avoidance of harmful low temperatures and sudden changes in temperature.
2. Conservation of heat needed for ventilation.
3. Less condensation of moisture on walls and ceiling.
4. Avoidance of damp litter by facilitating evaporation of the moisture from droppings.

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[5] This discussion does not refer to the keeping of hens in laying cages or batteries.

The degree of insulation and tightness of construction depend upon climatic conditions, size of house, and feeding and management practices. Costs of warm construction, controlled ventilation, and, in some cases, heating to maintain satisfactory house temperatures and dry litter should be weighed against the possible losses and the cost of extra labor and litter required to maintain satisfactory conditions in a cheaper house.

Summer Ventilation

In hot weather, free circulation of air through the house is essential; shading by trees and the insulation of the roof aid in protecting the fowls against excessive temperatures.

Areas of wall openings suggested for uninsulated, semi-insulated, and well-insulated laying houses vary in the four zones. These areas are expressed in table 3 as percentages of the floor area; a 10 percent area of wall opening in a house 20 feet square amounts to 40 square feet. In zone 1 openings generally are fitted with glass windows and in zone 2 with windows or cloth-covered frames or combinations of both. Windows and cloth-covered frames to be opened for winter ventilation should be easily adjustable, with allowance for swelling of wood parts when wet.

Table 3.—*Area of wall openings*[1] *for summer ventilation, stated as a percentage of the floor area*

Type of house	Combined front and side walls				Rear walls			
	Zone 1	Zone 2	Zone 3	Zone 4	Zone 1	Zone 2	Zone 3	Zone 4
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Uninsulated	(2)	10–15	12–20	18–30	(2)	1–4	4–8	8–20
Semi-insulated[3]	6–9	8–12	10–15	(2)	0–2	1–3	2–4	(2)
Well-insulated[4]	4–6	6–10	(2)	(2)	0–1	1–2	(2)	(2)

[1] Exclusive of area of entrance doors.

[2] Type not recommended for this zone.

[3] Includes straw-loft house without walls insulated.

[4] Includes straw-loft house with walls insulated.

In many houses in zones 3 and 4, openings in the front wall equal to 10 to 20 percent of the floor area are intended to be kept open at all times; additional openings are fitted with windows or shutters that can be closed in cold weather. Rear-wall windows are placed below dropping boards or above dropping pits. The area of glass seldom exceeds 2 percent of the floor area; additional rear-wall openings usually are provided with shutters and are often located in the upper part of the rear wall. Use of storm windows and weather stripping, especially on rear windows in zones 1 and 2, reduces heat loss and drafts in winter. All openings should be screened with 1-inch mesh poultry wire to keep out sparrows and other birds.

Winter Ventilation

During cold periods regulation of the rate of air change in the poultry house is necessary to avoid excessively low temperatures. In uninsulated houses this regulation may consist only in closing windows or curtains during storms and cold snaps, since moisture condenses on walls and ceilings and in the litter if the house is closed tightly enough to raise the temperature more than a few degrees. In a well-insulated house continuous restriction of ventilation is practical, but even in insulated houses, relatively large rates of air change are needed to keep interior surfaces and litter dry, since at temperatures of 30° to 40° F. a 4-pound hen exhales about 20 grains of water vapor per hour (*14*), or 0.07 pound per day, and voids in the droppings (*20*) about a quarter of a pound of liquid (the quantity of moisture varying somewhat with kind of feed), a total of about one-third of a pound (⅓ pint) of water per day.

To keep the moisture in the litter below 40 percent (see p. 7) it is necessary to remove about one-quarter pint of moisture per hen per day. If none of the moisture in the droppings were removed by evaporation[6] and ventilation, but all had to be absorbed, about 12 pounds of litter per hen per month would be needed. The air change required to remove the moisture varies with temperature and relative humidity outside and inside the house. For example, with a temperature of 10° F. and a relative humidity of 80 percent outside, and 15° and 80 percent inside, as in an uninsulated house, about 350 cubic feet of air per hen per hour would be needed to remove one-quarter pound of moisture per hen per day. With the same outside conditions, but with 35° temperature and 75 percent relative humidity inside, as in a large well-insulated house, about 60 cubic feet would be sufficient.

The hens can furnish only part of the heat necessary to warm the house and remove the moisture during cold weather. Since 25 hens occupy more floor space than 1 dairy cow, but emit only one-third as much heat,[7] additional heat is more needed in the poultry house than in the dairy barn.

In areas of much winter sunshine (fig. 3) the sun is a valuable source of heat, and in a house with floor or walls in contact with the ground the heat from the earth helps to warm the house whenever the air temperature is lower than that of the ground. Ground heat helps especially to avoid extreme drops in house temperature during cold spells. In weather with average temperature below 10° F. and less than 5 hours of sunshine daily, the combined heat from the hens, the sun, and the earth is not enough to maintain desirable temperatures and dry litter unless the house is unusually well insulated. Small quantities of supplemental heat applied under the litter (*10, 13*) or supplied by thermostatically controlled jacketed stoves or small hot-water heaters would greatly improve conditions in cold weather.

Systems for control of ventilation should provide uniform air movement through the house without drafts, especially in the roosting area, and provide freedom from excessive air changes due to wind or sudden variations in outside temperature. Several methods to accomplish this have been used, with varying degrees of efficiency. Among them are:

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[6] Moisture evaporates from litter about in proportion to the difference between the vapor pressure of the moisture in the litter and that of the moisture in the air. While actual data are not available, the following example will illustrate the theoretical relationships.

Pressure of water vapor in moist litter at 35° F. about 0.20 in. Hg (inches of mercury); in air at 35° F., 85 percent relative humidity, 0.17 in. Hg. With one 4-pound hen per 3½ square feet of floor space, moisture probably would evaporate about as fast as voided and litter would remain reasonably dry. If ventilation is restricted until air temperature rises to 40° with 90 percent relative humidity (vapor pressure 0.22 in. Hg, dew point 37°), moisture from air would condense on litter until litter temperature rises to dew point of air. If air temperature drops to 20° with 90 percent relative humidity (vapor pressure 0.09 in. Hg), there would be rapid evaporation from litter until it cools to air temperature; then moisture could no longer evaporate as rapidly as voided by hens, and litter would become wet. Rate of air movement would have little effect on changes except as movement brought in air of different temperature or humidity. For further information, see textbooks on physics or use psychrometric charts.

[7] A 4-pound hen produces about 40 B. t. u. (British thermal units) of heat per hour (*14*).

1. Adjustable windows or cloth-covered frames that are opened for ventilation; but pores in cloth soon become clogged with dirt (*1, 4*).
2. Openings louvered to deflect wind; but these are not adjustable.
3. Straw loft—combines insulation of ceiling with slow escape of air through straw; but inlets to admit air into the house and ample openings to the outside in attic must be provided (*3, 15, 16*).
4. Slot ventilation—a narrow, continuous, adjustable outlet near top of front wall, with narrow continuous inlet at sill of front windows; can be used with insulated houses (*7*).
5. Rafter ventilation with adjustable inlets or outlets between rafters at front or rear (*5, 6*).
6. Flue ventilation, both inlets and outlets required; operates best in insulated multistory houses (*5*).
7. Electric-fan ventilation—provides positive air circulation and may be thermostatically controlled; but manual control also is needed.

Inlets for most systems may take air either directly from the outdoors or from a room or passage where the air is fresh and not contaminated.

BUILDING DETAILS

FOUNDATIONS

Masonry foundations are recommended for permanent poultry houses. Footings should be not less than 12 inches below the ground surface in warm areas; 2 feet in zones 1 and 2. Local conditions and large houses may require greater depths. Footings for concrete block or tile buildings should be below the frost line. A 6- to 8-inch shelf extending outward from the bottom of the foundation helps to keep out rats. Anchor bolts should be provided not more than 6 feet apart, ½- by 15-inch size for a one-story house or ⅝- by 20-inch size for a two-story frame house. Foundations should extend 4 to 6 inches above the floor level—more if deep litter is used—to raise wood sills above dampness. Protection against termites (*19*) is needed in infested areas.

Where foundation walls are used for supporting wood floors, as on sloping ground, screened vents that can be closed in winter are needed to permit air circulation around the floor timbers; vents should be spaced about 25 feet apart. The total area of vents should be at least one-half square foot of opening for each 25 lineal feet of outside wall plus one-half of 1 percent of the ground area enclosed by the wall. Where piers and wood floors are used, the sill should be 12 inches above the ground and the space under the house should be enclosed with wire mesh to screen out poultry and trash. If houses are built on piers in cold climates, means of shutting out winter winds under the floor should be provided.

If ground water is high or is likely to seep down to the site from uphill, the use of drain tile or ditching around the foundations may be necessary.

FLOORS

Floors should be free from dampness and drafts and be smooth and easy to clean and disinfect. Floors constructed on the ground conserve warmth from the earth in winter, whereas warmth is lost by circulation of cold air under the floor.

Concrete is a good material for ground-level floors of permanent houses and is cool in summer. Much trouble from ground water and dampness can be avoided by proper construction. All sod and spongy material over the floor site should be removed and replaced with a fill of dry material, preferably coarse gravel or broken stone at least 6 inches thick. Cinders are likely to corrode water pipes. A sheet of durable, vaporproof material, such as light composition roofing, laid between the fill and the concrete will insure against moisture from the ground. Only 2 inches of concrete is needed if the fill is tamped solid. Sometimes hollow partition tile overlaid with a 1-inch topping of concrete is used. In cold climates a ½- to ¾-inch wide joint filled with moisture-resistant insulating material between floor and outside wall will reduce heat loss from the floor through the wall.

Unless adequate provision is made for drainage around the building and the walls in contact with the earth are properly protected from moisture, the top of the floor should be 6 inches or more above the outside grade and the ground around the outside should be sloped for a distance of 4 feet from the sides and rear to deflect runoff water. Sloping the surface of the floor to a drain or to an outside door facilitates removal of water when washing. A fairly smooth finish is desirable, as rough surfaces are difficult to clean.

Earth floors are difficult to keep sanitary and ratproof. They can be made more sanitary by stabilizing the earth with portland cement or asphaltic emulsions or by treating with oil.

Wood is commonly used for floors of movable houses, for houses built on hillsides, and for the upper floors of multiple-story houses. In some instances single flooring is used for economy, but double floors with building paper between are desirable, except possibly in the warmest climates. The top layer should be free of large cracks. The boards should be treated to guard against rot and termites.

The principal loads for which floors should be designed include (1) a man carrying feed—about 250 pounds concentrated load; (2) accumulated manure in dropping pits—up to 50 pounds per square foot of pit area; and (3) stored feeds—up to about 300 pounds per square foot of storage area.

Wire-mesh floors supported on strips are much used for outside sun porches and sometimes for floors inside the houses.

Roofs

Many types of roofs are used on poultry houses. Flat or slightly pitched roofs are difficult to keep watertight unless built-up roofing is used. The shed roof is commonly used on houses that are not more than 20 feet wide. Gable or combination roofs can be used on houses of any width and are generally used with the straw loft. Arched roofs are being supplied with some prefabricated buildings.

Walls and Ceilings

The wall should be wind- and rain-tight; walls and ceilings should be insulated as indicated on page 12 and finished with interior surfaces that can be kept clean and free of vermin. In single-walled houses in cold areas the inside wall above the dropping board and the under side of the roof usually are sheathed tight to the front of the dropping board. Fibrous materials within reach of the hens should be protected to prevent them from pecking holes.

Insulation

The insulating values [8] tabulated below and described for common types of walls and roof construction in figure 5 are suggested as minimums for poultry laying houses 20 by 20 feet in size or larger. Because of the larger wall area per hen both the cost and the heat loss per hen are greater in small than in large houses.[9] Insulation should be protected by a hard, strong covering where exposed to pecking by hens or other damage. Insulation values desirable in walls and ceilings in the different climatic zones follow:

	Walls	*Ceilings*
Zone 1:		
Coldest parts	10	12
	or 8	15
Warmer parts	6	8
	or 5	12
Zone 2	4	6
	or 3	10
Zones 3 and 4	1. 5	4

VAPOR BARRIER

A vapor barrier is needed on the warm side of fibrous or fill-insulating materials to prevent water vapor in poultry-house air from condensing in the insulation. Shiny heavily asphalted paper, aluminum foil, lightweight roll roofing, or two coats of asphalt or aluminum-flake paint are examples of satisfactory vapor barriers; tarred felt, red resin paper, and ordinary paint are not satisfactory materials. Unless the vapor seal on commercial insulation is guaranteed to stand up under continued exposure to high humidity, an additional barrier also should be used. Spaces packed with fill insulation should breathe to the cold (outer or upper) side to assist in drying out moisture that might penetrate through the barrier.

Bracing

Poultry houses should be firmly anchored to the foundations to avoid damage by high winds. The roof rafters, plates, studs, and sills should be tied together so that any uplift of the roof will be transmitted to the foundations and not tear the wall apart at any joint. The center girder, joists, and posts should be secured similarly against uplift, and the dividing partitions in long houses also should be securely fastened to the roof and foundation.

FIXTURES

Roosts

Roosts are set above dropping boards or pits and generally are located parallel to the rear wall, though in very wide houses they are sometimes set out into the room. Roosts should be of 1½- to 2-inch stock rounded on the upper edges. Simple assemblies with a mini-

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[8] The insulating value represents the number of degrees difference in temperature on the opposite sides of a wall that will cause 1 B. t. u. (British thermal unit) of heat to flow through an area of 1 square foot of wall in 1 hour.

[9] A 10- by 10-foot house, 7 feet high and housing 25 birds, has 11.2 square feet of wall area per bird; a 20- by 20-foot house, 7 feet high and housing 110 birds, has 5.1 square feet of wall area per bird. To maintain the same temperature in a 10- by 10-foot house as in one 20 feet square would require that the wall insulating value of the small house be more than twice that of the larger house.

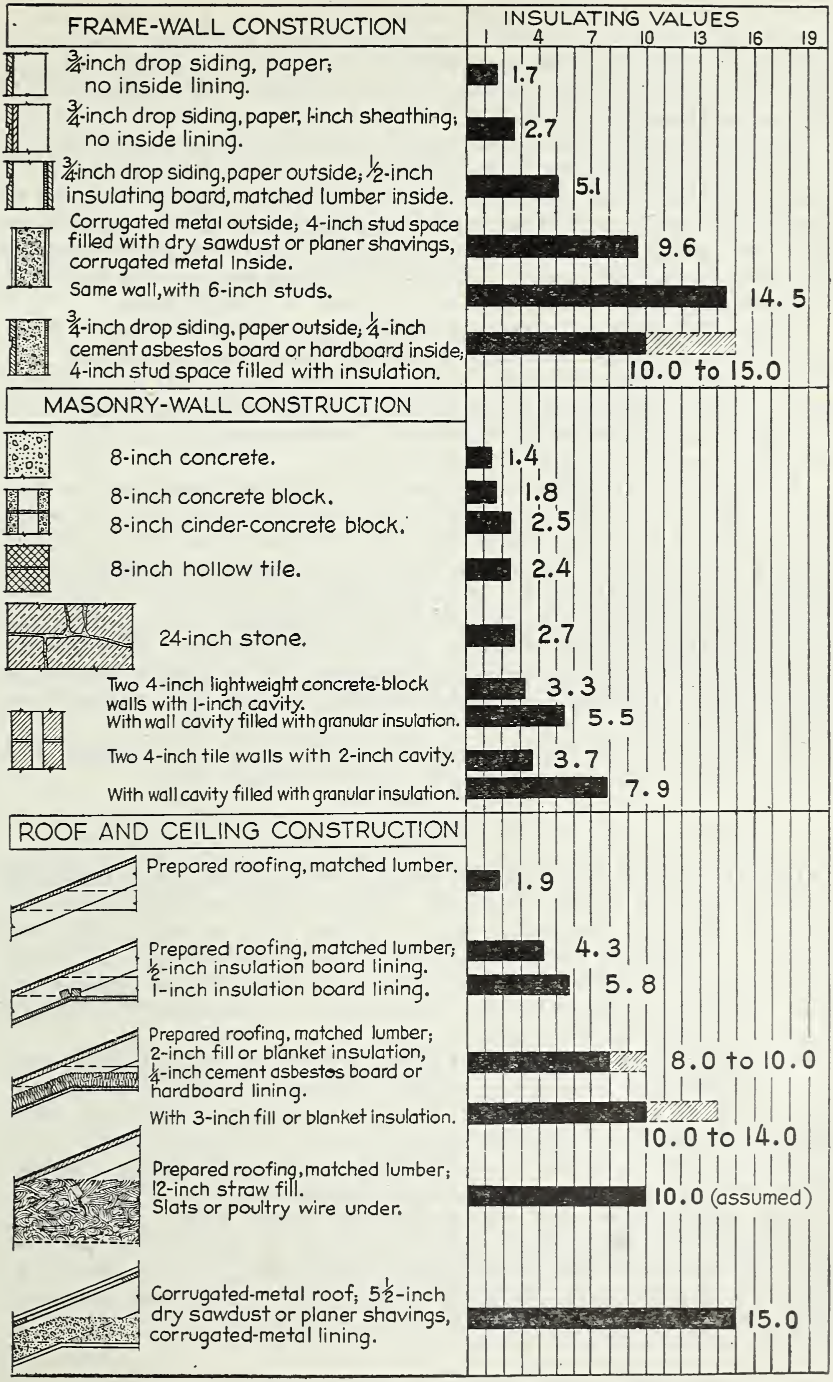

FIGURE 5.—Insulating values, common types of construction.

mum of cracks or joints where mites can hide are desirable. Small breeds require about 8 inches of roosting space and large breeds 8 to 10 inches. The roosts are usually set 6 to 8 inches above the dropping boards or on top of pits and 13 to 15 inches apart. Dropping boards and roosts should be creosoted.

Many poultrymen prefer all roosts on the same level; others step the roosts up from front to rear with about 2-inch difference in level between them. The roosts should be made removable or fastened to frames that can be raised for removing droppings. Hens can be kept out of droppings by using 1½-inch hexagonal or 1- by 2-inch 16-gage wire mesh under the roosts. The front opening between the wire and the dropping board should also be screened to exclude hens.

Dropping boards are placed 24 to 30 inches above the floor. They can be built in place, although if built as removable panels they can be more thoroughly cleaned. Sometimes they are built as sectional benches that can be moved away from the wall, thus permitting better circulation of air in warm weather. Surfaces should be tight and smooth to permit removal of droppings.

Dropping pits are often used instead of dropping boards and reduce the frequency of cleaning. The pit—actually a boxed-in space—extends about 18 inches above the floor, the width depending on the number of roosts. The front of the pit should be enclosed with boards or a concrete curb. Board panels are sometimes made removable to facilitate cleaning out the droppings. The roosts and wire-covered removable or lifting panels are set on top. Wood floors and side walls of pits should be creosoted or otherwise protected against rot. When pits are used, windows in the rear wall are set above the roosts.

One hundred hens will produce 85 to 120 pounds of manure per week, or about 2 to 2½ bushels (2½ to 3¼ cubic feet) (*20*).

NESTS

One open nest is needed for every five to six hens or one trap nest for three or four hens. Entrance to nests can be either from the front or the rear, depending upon whether light or dark nests are desired. Individual nests should be 12 to 14 inches wide, 14 to 16 inches long, and about 14 inches high. Wire partitions between nests and a wire floor for the passageway of dark nests provides greater coolness in hot weather.

Individual nests are usually placed in tiers on the partitions and end walls with the bottom tier about 18 inches above the floor. Landing perches should be provided at each tier along the front of open nests; they can be hinged for closing the nests when raised. The top tier of nests should have a sloping top to prevent roosting. Knockdown or removable nests can be kept more sanitary.

Some poultrymen use community or tunnel nests. These are movable 2- by 6-foot boxes on short legs, 16 inches high at the low side, with a sloping top, no partitions, and an entrance at each end. Such a nest replaces 12 to 15 individual open nests, but cannot be used for trap nesting.

FEED HOPPERS

Small portable feeders, or troughs that can be refilled frequently, are recommended. Mash hoppers should have about 2½ inches feeding space per hen. The devices should be constructed to prevent waste and permit easy filling, and be so arranged that hens cannot perch on them. Two 6-foot troughs providing 24 feet of feeding space would easily accommodate 100 hens. Where yard feeding is practiced, weatherproof feeders are needed to protect the feed. Smaller hoppers for oystershells and grit can be hung on the walls. In some cases green-feed hoppers are used, and space for feeders should be provided.

FEED STORAGE

Feed storages protected from rats should be provided on the basis of one-quarter pound of feed per hen per day for the storage period. Usually two mixtures of feed are used. In a small house feed may be stored in metal cans or barrels, but in a large house a separate feed room is justified.

WATERERS

As much as 6 to 8 gallons of water per 100 hens per day is needed in hot weather. The supply should be protected from contamination and spilling. It is well to provide a wire platform around the fountain with a drainage pan under it to catch spilled water or drippings from wattles and beaks. With large-sized flocks automatic fountains are labor savers. In houses where temperatures may go below 32° F., water pipes must be protected and waterers should be of the non-freezing type.

ACCESSORIES

Broody coops are necessary in the laying house. Manure pits and incinerators facilitate sanitation. Feed, egg, and litter carriers may be installed to save labor in large houses.

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